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ABSTRACT

This paper presents a study that examined the processes used by a school community and school leaders in a K-4 elementary school to implement reform mathematics instruction. The research, based on a case study, explored the changing nature of classroom environments, where teachers created learning opportunities, and the transformation in leadership strategies and changes in teachers' roles and relationships. Overall, the paper discusses the creative tension between two cultures within the school--tension that seemed to foster continual renewal and professional growth. The report looks at the switch from behaviorism to constructivism in the classroom and how constructivism recognizes students and teacher as a community of learners. It provides a number of vignettes of how reform measures operated in practice and how teachers came to understand the diversity of strategies and procedures students "invented" to solve problems. The paper also describes the creative tension between teachers who employed reform strategies and those who did not, and it discusses the principal's role in reform. New roles and relationships grew out of the collaborative decision-making between teacher-leaders and principals, and teachers began to realize that teacher leadership was necessary for instructional reform. Ultimately, success hinged on the teachers' willingness to take risks. (Contains 10 references.) (RJM)

Challenges of Instructional Leadership for Reforming School

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HEADING: Challenges of Instructional Leadership

The Challenges of Instructional Leadership for Reforming School

In 1989, two major publications addressed the issue of reforming mathematics education in America. These reports proposed wide-ranging, radical changes in mathematics learning and teaching. Everybody Counts: A Report to the Nation on the Future of Mathematics Education written by National Research Council (1989) concluded that ineffective mathematics education posed a potential threat to America's economic security in a technological world. Curriculum and Evaluation Standards for School Mathematics written by National Council of Teachers of Mathematics (1989) echoed similar views and drafted recommendations intended: (1) to expand school mathematics away from "shopkeeper's arithmetic" (2) to include mathematics meaning congruent with the needs of the 21^{st} century and (3) to establish instructional beliefs and practices based on the epistemological foundations of constructivism.

The need for instructional reform in mathematics was clearly documented in 1989. However, how to lead this type of reform and what impact such an epistemological shift would have on school change are unknown. Moreover, the literature did not anticipate how individuals within an organization would interpret and respond to major change in traditional beliefs and practices. It remained unclear how some educators may initiate and implement major change.

The intention of this research is to share the processes a school community and school leaders (principal, assistant principal, teacher leaders) in a K-4 elementary school created to reform mathematics instruction. In particular, the case study reports the complex and dynamic nature of an epistemological shift from behaviorist teaching approach toward constructivist methods of teaching and learning mathematics. The case study explores the changing nature of classroom environments, where teachers create learning opportunities for students to make sense of *doing* significant mathematics through social interaction, dialogue and mathematical modeling. The research reveals transformation in leadership strategies and changes in teachers' roles and relationships. Overall, the paper discusses the creative tension between two cultures within the school which seems a source for continual renewal and professional growth.

From Behaviorism to Constructivism

Reforming mathematics teaching and learning at this K-4 school represented a major shift in epistemology. The process of this shift from a behaviorist perspective on teaching and learning mathematics to a constructivist perspective was non-linear and uncertain. Behaviorist methods of instruction and assessment focus heavily on transmission of knowledge from teacher's head to student's head through direct instruction and testing. In contrast, constructivist methods of instruction value problem solving, reasoning, communication and mathematical representation (NCTM 1989, 1991, 1995, 1998). Constructivist classrooms differ from conventional classrooms in several ways. First, such classrooms recognize the students and teacher as a community of learners. Second, student-student and teacher-student interactions and dialogue are valued as *ways of knowing* and negotiating meaning. Third, these classrooms emphasize putting mathematics in context so students make sense of numbers, computations and formulae as they occur in some real life situation.

To build a clear picture of school change, the following section focuses on constructivism in the classrooms. Salient features of constructivist theory and the kind of changes constructivism suggest for mathematics instruction and assessment at this school are described. Gradual changes in assessment and instruction are portrayed through several vignettes. Each vignette demonstrates the range of instructional practice within mathematics classrooms and chronicles the kind of changes happening in many, but not all classrooms.

Constructivism in the Classroom

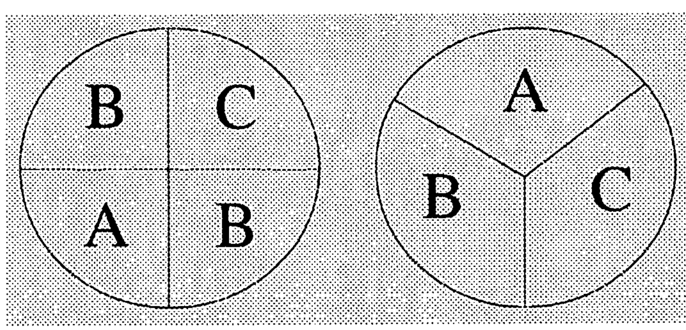
When the reform started, there existed little research on how to implement major instructional reform in mathematics or how to lead an epistemological shift for educators and parents. This lack of research placed educators and change agents at this school in a vulnerable and precarious situation. They found themselves in unfamiliar territory within a familiar landscape of a traditional school district. Telling the story of mathematics reform, the educators leading it, the dilemmas and conflicts they encountered, the strategies they created, the decisions they made and how they chose to communicate about change to others may contribute to an understanding of the complex and dynamic nature of school reform. The following two vignettes attempt to provide a glimpse of the role school leaders assumed and what the reform involved.

Principal As Teacher

Seven fourth grade students, from three different classrooms, were randomly selected from the After School Childcare Program. Students seemed eager to work with the assistant principal. She often taught mathematics in their classrooms. They all sat in a circle at the back of the room. One student, however, immediately distanced himself from the circle and leaned against the radiator. The assistant principal posed the following problem:

Assistant Principal: You are a contestant in the "Big Spinner Game." To win the game, the tip of the needle must land on the letter "B." Which of these two spinners would you select to win this game? [In the middle of the circle is a large 18" x 24" tablet of newsprint. She draws two large circles. One circle is divided into thirds. Each section is labeled "A" "B" "C". The second circle is divided into fourths. Two of the sections are labeled "B" and the remaining sections are each labeled, "A" and "C."

Figure



AP: John, are you feeling all right? [John is sitting outside the circle.]

John: Yeah.

AP: Why don't you join us? Or are you more comfortable over there?

John: I'm more comfortable over here. I'm just kind of tired.

AP: O.K. but don't get burned by the radiator.

John: I won't.

AP:	Now here's the situation. You are at a carnival. One game at the carnival is a game where you can win a television-VCR if the needle of the spinner lands on the letter "B". Landing on the letter "B" wins the TV- VCR. The rules of the game are simple. Before you play the game, you have to choose which spinner to use. You get a choice of spinners. Everybody understand so far?
Students:	Yes.
AP:	What do you think my question is about this problem?
Sally:	Which spinner would we choose to make sure we would win on just one spin.
AP:	That's right. Let me write your question on the paper. [Assistant principal writes the question.]
AP:	OK. Now just to make sure we all understand the problem. Who can retell the problem? How about you, Ted? Now, everybody listen to make sure this is how you see the situation. Make sure important information isn't left out.
Ted:	Well, we're at the carnival and we want this TV set…
John:	and VCR combination! [students giggle]
Ted:	Yeah, right. At this game we have to select a spinner to use. Landing on the letter "B" wins the game.
John:	You have to do it the first time---no second chances at spinning.
Ted:	Yes, only one spin.
AP:	Is that how everybody understands the problem?
Students:	Yes.
AP:	OK, which spinner is best to use for this game?
Students:	silent and thinking
AP:	Yes! I hear thoughts, smell brain cells burning. What's the problem here?
Alice:	It isn't easy. It's tricky.
Bonnie:	Yeah, you repeated the "B" in the circle with the fourths.
John:	[now, a little closer to the circle] The parts aren't the same size either.
AP:	What were you expecting, a "no-brainer" activity from me?

Students: NO!

John: [now laying on the floor within the circle] I would take this spinner [pointing to the spinner divided into fourths].

Bonnie: No, you shouldn't take that one, the sections are smaller than the ones on this spinner [pointing to the spinner divided into thirds].

Alice: But there are more B's on this spinner.

John: Yeah, more B's means more chance to win.

Bonnie: But you are counting "B's", you aren't looking at the part. 1/3 is bigger than ¼.

John: But there are more B's here. See, ¼ and ¼ is two fourths.

Ted: No, that's not 2/4, it's one half.

Students: [pause, a little discussion among themselves]

AP: Um, 2/4, ½, which is it?

John: Its 2/4 because the spinner is divided into four equal parts. Two of those equal parts have "B's" on them. 2/4 "B". [John, now sitting up, folds arms across chest.]

Bonnie: [quietly] I think it is the same, John. You can say 2/4 or ½ "B". It's the same, look. Here's one half of the circle [tracing one half of the circle with her finger]. Now here's two fourths [tracing sections of circle again]. 2/4 and 2/4 equal one whole circle.

Aaron: [who has been listening intently] Either spinner will win.

AP: What do you mean?

Aaron: ¾ needs ¼ to be a whole. And 2/3 needs 1/3 to be a whole. Since they both need just *one* piece to be a whole, they must be equal and either spinner will win the game. [Students are quiet and puzzled.]

John: I don't know about that.

AP: I don't know either. You folks have me most confused. I am going to have to think about this. I never thought about it this way. I think we will have to continue this discussion sometime tomorrow. [Her way of ending lessons when she is unsure about how the students are thinking and how she needs to continue the instruction.]

Teacher as Mentor and Staff Developer

The following vignette describes a conversation between students and two teachers about "time." In this situation, the teacher-leader was modeling a lesson for her mentee. The intent of the lesson was to investigate what students already knew about "time" and to use their understanding to create lessons. The students were required to dialogue with each other and to explain/defend/justify their ideas. The unanticipated result was a perturbation of teachers' understandings about students' prior experiences and present thoughts.

Setting: Fifteen "at-risk" mathematics students are sitting in a circle, on the floor, with two teachers. One teacher-leader (TL) is the mentor of the other teacher (T). The teachers are preparing students for the State Proficiency Test in mathematics. Each student has a small, yellow plastic clock.

TL: So, what do you know about time?

S I: There's twenty-four hours in a day. Seven days in a week. Thirty or thirty- one days in a month. Four weeks in a month. Twelve months in a year.

TL: Anything else that needs to be added? Anybody know other things about time?

S II: He left out ten years in a decade.

S I: Oh, yeah. And one hundred years in a century. Thousand years in a .....I forget.

TL: Anyone know? [Students, thinking, are silent.]

TL: Well, I'm not sure either. So, let's go on. What about this thirty or thirty one days in a month? Why those numbers?

S II: I think it has something to do with the earth or sun.

S III: Yeah, it does. Um, let me see if I remember. It's how long it takes the earth to spin around.

S IV: No, that's the time for a day—one complete spin---12 hours of day, facing the sun, 12 hours of night, facing away from the sun equals one complete day. But I can't remember about months. Maybe it has something to do with orbit around the sun.

S V: Yeah, it has to do with orbit. Like where in the orbit the earth is.

S VI: Yeah, whether it is close or far from the sun.

S V: It never gets close to the sun or it would burn up!

S VII:	But it has to get close sometimes because we have summer and winter. [Students are silent.]
TL:	Hum, I don't know about this orbit. Let's go back to one complete spin. Does everyone agree that one day is measured when earth spins completely around one time?
Students:	Yes.
TL:	And that one full day is measured in hours?
Students:	Yes.
TL:	And that one spin takes 24 hours?
S VIII:	Not always.
TL:	Oh, tell me when it doesn't take 24 hours?
S VIII:	Well, sometimes it goes faster. Sometimes it goes slower. But most of the time it takes 24 hours. [Teacher leans forward and responds to student's comment.]
T:	That's not right! Where did you get that idea?
TL:	Let him finish. I am interested. There is fast time and slow time?
S VIII:	Yes.
TL:	I never thought about time this way. What does everyone else think?
S I:	Time does go fast and slow. Like waiting for Christmas or my birthday, time goes slow. Vacations go fast.
S IV:	Yeah, I agree with you. Sometimes school goes fast and slow, especially lunch! [Students laugh and smile to show agreement.]
TL:	So, let me understand. You're saying that time is measured in hours but sometimes those hours go fast or slow. So what about the earth's spin? Does the earth spin faster one day than another? [Students think about the question.]
S I:	I think it spins slower in spring and summer than in winter and fall because the days are longer in spring and summer.
S III:	Yeah, that's right. My bedtime is 8:30. In the summer I hate going to bed when it is still light outside. In the winter, it is dark. That's because of fast and slow time.
TL:	Well, if hours go fast and slow, do months also go fast and slow?

S IX: Yes, look at the months, some are thirty days, some are thirty-one and February is 28 days.

S X: Sometimes it is 29 days.

S IX: Yeah, but only once every four years.

TL: This is most interesting. Fast and slow hours, days and now months. I guess I always thought that an hour was always the same length of time. It didn't speed up or slow down. Now you are telling me that February is "fast" for most of the time but every fourth year, February slows down and takes one extra day.

S XI: That's right because that's "Leap Year." One extra day is added to the calendar. Instead of 365 days, there's 366 days that year.

TL: What makes this happen?

S XII: Probably the earth just stands still in its orbit.

TL: Who then "jump starts" earth moving again? [Students are quiet.]

Later that day, after school the two teachers met to debrief the lesson and to plan instruction.

T: Why did you let them continue with that nonsense about "fast and slow" time? Where did they get that notion? It was so painful to listen to. Eventually, you should have told them how wrong they were.

TL: I couldn't tell them they were wrong because I didn't have a way to change their thinking that would make anymore sense to them. I didn't find the situation "painful." I found it intriguing how they built such elaborate misunderstandings to make sense of time. Now, we've got to figure out how to dismantle these perceptions and help them construct it differently. Before I do this, I have to revisit science concepts and make sure I understand orbits, rotations, revolutions and seasons. Then, I suggest we create experiences we let them see that time is measured in a regular constant rhythm. Erasing misunderstandings will probably be more difficult than building new.

T: You've got that right. Just think, we've got to explain "leap year!" [Both teachers laugh.]

Several factors contributed to gradually changing teacher beliefs and classroom social norms. The first factor was listening to students' explanations of their solutions. Teachers were surprised by the diversity of strategies and procedures students "invented" to solve problems. The second factor was realizing what teachers taught was often not how students understood mathematics. A third factor was the experiences and contexts students used to make mathematical meaning. "Student voice" was a powerful catalyst for impacting teachers' instruction, practice and content knowledge. "Student voice" played a role in lessons that teachers designed. It was not uncommon for teachers to use individual student experiences and a student's name in a mathematics problem.

> The way we are teaching now is a lot harder. Many people aren't ready. The knowledge of math that is required now is more difficult. There is an element of belief in what we are doing. You really have to believe it. People have to experience it in order to change their whole schema. (teacher-leader)

Understanding students' thinking as revealed in classroom dialogues is fundamental to instructional reform in mathematics (Pourdavood & Fleener, 1998). The above professional dialogue reveals the importance of communication and shows the variety of new roles for teachers such as: teacher as reflective person, teacher as adult learner, teacher as instructional designer, teacher as intellectual. These vignettes may also suggest key roles for students as part of instructional design and catalysts for teacher learning.

As demonstrated by above vignettes, the range of instructional changes in the classrooms are different and dependent on teachers' understanding, involvement and commitment to the reform process. Questions remain about how and why these changes occurred? What strategies were necessary to promote teacher change? What leadership decisions nurtured risk-taking and encouraged teacher change? What impact did leadership decisions have on the nature of reform and the culture of the school?

Creative Tension Between Two Cultures

This section explores the various strategies used by the school principals and teachers-leaders to implement NCTM Standards. The impact these strategies had on existing socio-political norms and school structure is also examined. Key leadership decisions and strategies that facilitated, sustained and incubated the change process are discussed. Furthermore, the section discusses some of the tensions that emerged as a result of instructional reform. It begins with background information about the two principals who played significant roles in the story of the school change. Then, the dialectical relationship between socio-political tensions and the reform process is examined. For purpose of clarity, those teachers who support the reform are called "teacher-leaders." Teachers who do not actively support reform are called "school educators." "Teachers" refers to all classroom teachers in the school.

Role of Principals in School Reform

The process of instructional reform in mathematics can not be fully understood without a closer look at the role two principals played over the last ten years. The school principal, earned his Ed.D in school administration/curriculum and instruction. He was an assistant principal at the middle school level for five years before he was appointed an elementary school principal. As assistant principal, he became aware of how the culture and structure of school presented problems for student learning. He saw that the structure and culture of schooling often limited children's time to learn and stifled their intuition, creativity and imagination. He wondered if there was an alternative way to help all children learn.

When he became the elementary school principal, the national reform agendas in language arts (whole language) and mathematics (NCTM, 1989) challenged him to help lead teachers to recreate how they taught children to read, write and do mathematics. The principal's role changed when he abandoned his position as a traditional administrator/manager and stepped into the role of principal as teacher, action-researcher, and learner.

The assistant principal was appointed in 1995. She was a former second grade teacher and staff assistant in charge of instruction at this school. She earned her Ph.D in school administration. Her doctoral dissertation focused on the implementation of the NCTM Standards and the impact these Standards might have on the lives of elementary teachers (Cowen, 1995).

To fund the reform efforts, some teachers and the two principals wrote grants. They invited university and secondary mathematics teachers to work as consultants with elementary educators. Secondary mathematics teachers, principals and a university professor played a key role with teachers by interacting with students in classes and modeling instructional ideas and constructivist practices.

From 1990 until 1996, teachers' participation in reform was voluntary. Everyone seemed "happy" and the school appeared to be in "harmony."

> This building came together as a product of reorganization. I was the only one from [name of the school] assigned here. I found the staff very open, full of laughter, and a lot of fun . . . the principal would visit from time to time. It was great when he came to my room, because he would see my children doing a lot of hands-on activities. I felt that I was a real leader. (school educator)

Disequilibrium and tensions began in 1996 when the instructional reform became mandatory and all teachers were assigned to K-4 instructional design teams led by senior and non-tenured teachers. Using non-tenured teachers as leaders was resisted and thought unusual by some educators. The process of change suddenly shifted from equilibrium to disequilibrium because sensitivity to small changes were amplified and potentially fractious.

> I took a sabbatical for half of the year three years ago to observe split classes. I even volunteered to take a K-1 split. I was in this building every other day modeling teaching. I did school visits all over and taught classes. It was a wonderful time for me. But it was when the reform was starting and I was not a part of it. I came back and was not included the next year either. Last year we all got together in "break-out groups" and I don't know how much my input is valued. I don't philosophically even agree with everything that is being done. I believe in change for a reason, not just for change sake. I guess that is where I differ . . . At our individual meetings, I was listened to, but when my team leader would go to the other meetings, I didn't get the impression that what I was saying was really valued. I've been given the impression that there is a right way to teach math and a wrong way to teach math. And I was told last year that I wasn't teaching math right. To be told, with my background that I could not attend NCTM because I wasn't teaching math right was a shock!!! . . . I worry that children who are visual learners are being left out the loop. Enlarging the print is not enough. When I posed this problem, I was yelled at and told that if I just enlarge the print that would take care of it . . . The important thing is that we respect everyone. I don't think that's happened. (school educator)

Tensions arose between supporters and non-supporters of the reform. These tensions signaled deeper layers of internal conflict and posed constant challenges for the principals.

Principals played a significant role in the development of a critical mass of teachers to guide the reform. By supporting, mentoring, and nurturing teachers who were willing to participate and contribute to the local school reform, the principals gradually built a team of teacher-leaders. Without these teacher-leaders, reform would probably have dissipated. A few teachers felt isolated and excluded from the change process and from leadership opportunities. Tensions, resistance and mistrust grew among this small group of teachers.

Evolving Nature of Instructional Reform

The principals devised ways to expand teachers' content knowledge through on-site staff development sessions where teachers handled new instructional materials ("manipulatives") and learned within a constructivist climate. Through professional development sessions, many teachers began to realize that mathematics could be learned through hands-on experiences and dialogue, something that had been absent from their own experiences and education in mathematics.

> I love teaching math because it is so different from the way I learned it. But it has also been the hardest thing for me because I learned it in a very traditional setting. That is not how we should teach math because it is not what is best for children...To create something new everyday takes a lot of energy and a lot of work. (teacher-leader)

Early in the reform effort, there were not many studies published about the implementation of the NCTM Standards. Teachers and principals researched and collaborated with university and secondary mathematics educators to better understand major ideas in mathematics and to create curricular, instructional and assessment practices reflective of constructivist theory. Teachers invented a restructured, streamlined mathematics curriculum focusing on main mathematical ideas such as: *unit, unitized systems, zero, infinity, change, chance, dimensionality, location* and key processes of: *combining, partitioning* and *comparing.* Teachers developed lessons and performance task assessments that valued problem-solving, reasoning, communication, modeling and student experiences. "Whenever I leave this building, I leave feeling better than I came in" (secondary mathematics educator).

Students' writing, modeling and discussions revealed the connectivity between mathematics instruction and assessment. The traditional report card system was inadequate because it lacked the authenticity called for by the NCTM Assessment Standards (1995). Therefore, educators at this school began to develop an authentic assessment system congruent to the NCTM recommendations. The new system gave a more open and realistic assessment of student growth. A team of elementary and secondary teacher-leaders designed a series of performance tasks that would: (1) capture student growth over time, (2) act as instructional targets for teachers, (3) encourage reading in the context of mathematics and (4) assess the application of skills and students' understandings about mathematics. Performance tasks were given to students in fall, winter and spring. These tasks were created to show cognitive growth and connect assessment to classroom instruction. However, there existed no models to show how student writing and illustrations about mathematics could be evaluated. Overall, the process of restructuring and reculturing mathematics K-4 education at this school was non-linear and uncertain. These teacher-leaders and principals stepped into unknown territory. They made their "roads by walking" (Horton & Freire, 1990).

Teachers As Writers

Teachers as writers and creators of instruction and assessment were important for the reform. "Teacher" as "action-researcher," was a new role. They tried out new teaching, learning and assessment practices, read and implemented research in their classrooms. In teacher-leader meetings, they reflected on these experiences. Their action research was shared, revised and collected into documents for all teachers. "These math problems need revision this summer. But then I guess we will always be rewriting them each year. Who would have guessed we would be doing this?" (teacher-leader)

As the reform evolved, many educators struggled to make mathematics relevant to students' personal experiences. Educators were not accustomed to active and interactive instruction. Nor were they accustomed to listening to students' voices and designing instruction around student understandings and misunderstandings. "When this reform started, I did not agree with it because I did not understand it. I had to have a conversion. I had to come to a place to understand it" (Teacher-leader). The reform also exposed teachers' limited content knowledge of mathematics; which led some teachers to feel insecure, inadequate and resistant to change.

> I would fight with the principal all the time. Every time he came into the room I would be using the math book and doing drills. I just couldn't accept that I couldn't do it [math reform]. It caused some tension and a breakdown of communication. He couldn't convince me, and I couldn't see anything else. I didn't try because I didn't believe in it. (teacher-leader)

Most teachers discarded their dependency on mathematics textbooks and weekly pre-determined lesson plans. Moving away from prescribed instruction and textbooks added to the disequilibrium in the school.

> I enjoy the autonomy I have here. At other schools, lesson plans eliminate 'teachable moments.' I would have to stop and rethink. I usually have a general direction [ideas and processes] and I don't write lesson plans more than three days in advance. I change them so often. (teacher-leader)

Despite the emerging instability and differing perspectives, most teacher-leaders continued to design lessons that targeted the performance tasks. Their lessons had students solve problems within the context of unitized systems such as *time, money, weight, capacity* and *temperature*.

There seemed to be a close relationship between teachers' and students' mathematical empowerment where teacher and students created instruction together and assessed their cognitive growth(Grundy, 1987). This relationship seemed to produce a synergy among members of classroom communities where student voices echoed their confidence in doing sophisticated mathematics.

> The problem is we don't know how to translate 7/16 into cents. The price per share means how much we paid and how much the stock went up. We do this every Wednesday... (Fourth grade student)

Teacher as "action-researcher" and "writer" evolved in other ways. Teachers sought new ways and materials to improve their classroom instruction. They wrote grants. As "action-researchers" they were expected to report on their classroom "research" at grade level and staff meetings. Teacher as "instructional designer" was fundamental for adult learning. Early in the reform it was clear that teachers reflected on what they knew about mathematics and connected it to how children learn mathematics. Teachers writing instruction had a significant impact on staff development programs. Staff development was organized to expand teachers' content knowledge, design instruction write assessment tasks.

Changes in Classroom Environments

> You know, I was thinking on my way to work this morning how differently I teach now. You wouldn't believe how I used to teach. Before, I used to "sugar coat" the curriculum, make a big show, entertain the kids to keep them from being bored. I never thought about the substance of my lessons or if they helped students learn. I just assumed they did. But, now, I listen to the kids before designing lessons. I am always thinking about how I can improve so the students will really learn. I feel so much more fulfilled than before. I could never teach that way again. (teacher-leader)

In some classrooms, mathematics instruction evolved away from a reliance on mathematics textbooks/workbooks, "feed-in, feed-out" instruction and lectures toward instruction and assessment practices that reflected problem-solving, reasoning, and communication.

Social norms of some classrooms also began to change. There were gradual shifts in what teachers valued for mathematics instruction. There was a shift away from students remaining at desks and working independently toward the development of a small learning community where teachers and students sat together on the floor and mutually constructed understandings. These changes encouraged/ignited changes in how mathematics was communicated in classrooms (Pourdavood & Fleener, 1997). Students and teachers often sat on the floor with one set of manipulatives, a large tablet of paper where students and teachers drew their understandings and discussed a problem situation. These classrooms were characterized by: (1) listening to all students, (2) valuing multiple solutions and procedures, (3) encouraging risk-taking, (4) valuing diverse student experiences, and (5) seeing the individual student as a co-contributor of instruction.

However, in a few classrooms, instruction remained dominated by "teacher-talk" and question-answer format. These classes were often characterized by: (1) linear communication between student and teacher where teacher elicited and validated correct answers, (2) emphasis on efficient and reliable algorithmic procedures, (3) limited support for student risk-taking, and (4) formal classroom experiences that did not always value student's prior experiences and understandings. Classroom differences were noticed by visitors and parents. Parents began to refuse the placement of their children in these conventional mathematics classrooms. In general, parents requested teachers who were building constructivist classroom environments.

Assessment practices began to rely less on uniform grade level learning outcomes that ranked and rated students. Authentic assessment tasks valued individual student performance and developed individual learning goals based on student progress. Conferences moved away from twenty-minute, teacher-parent conferencing about report card grades. Conferences changed to focus on student portfolios and student-led assessment meetings where teachers, students and parents collaborated to evaluate student performance, chart growth over time and establish learning goals.

> There has been a big improvement in math this year. She really had problems in math last year. But now I see her level of interest is very high in math and she is growing in problem solving. Before, she would say that she 'hates math' but now, she likes it. She is more confidant in her problem solving and reasoning. (Fourth grade parent)

These interactive parent-teacher-student conferences required more than twenty minutes. Some teacher-leaders urged their union leaders to negotiate for additional conference days in the teachers' contract. They also asked the principal to persuade district administrators to bring this issue to the bargaining table. However, both union and administrative leaders did not bargain for additional conference days. So, some teacher-leaders extended their conference day beyond the contractual agreement. A few teachers held evening conferences. Conflict arose over evening conferences when teachers wanted to accommodate parents' schedules and substitute evening conferences for daytime ones. Principals were told that teachers could not use "after hour" and evening conferences as a substitute for being present on the scheduled conference days. Also, principals were told that no substitutes for a teacher who was conducting conferences after school or in the evening on a regular school day.

Some Final Remarks

New roles and relationship grew out of the collaborative decision-making between teacher-leaders and principals. Some teachers began to realize that teacher leadership was necessary for instructional reform. By putting research into practice and developing instructional models, teachers began guiding and mentoring other teachers. Their efforts also built trust and respect with principals and helped principals understand what changes were working and what changes were not working.

Conflict was both beneficial and disruptive. It moved the reform forward by helping to create a critical mass of teachers who supported instructional change. Conflict created a situation where there was no "middle ground." Teachers either implemented the reform or they did not. Conflict also did damage. Support or non-support of the reform was viewed by some teachers as support or non-support for the principals. Disagreements about changes in rules, roles and relationships caused a few teachers to resist instructional change and make attacks on professional abilities of principals and teacher-leaders. Teacher-leaders were perceived as "principals' puppets." The attacks helped mold a strong, cohesive teacher-leader team that helped the principals develop a strategy of co-existence. "... We can go forward without them. They had opportunities to join and they didn't. Don't spend time getting them 'on board.' It holds us up. We can handle this" (teacher-leader).

Various reactions toward the reform added to the tensions. "We've done this ' gig' before. This is nothing new. We've had 'hands-on' materials in science, now its in math" (school teacher). Few teachers seemed to anticipate the complexities of implementing the NCTM Standards. No one was really prepared for the dissension caused by different philosophical perspectives. Most teachers underestimated how much the existing educational structures prevented change.

> Early on we loaded up our wagon with manipulatives, pulled it past the "dragon at the gate." We got by because the "dragon" has seen 'hands-on' stuff before, so we pulled the wagon through the gate. But when we began changing our beliefs, values and practices to reflect constructivism, the "dragon" got angry and the fight was on. No one disturbs the "educational dragon." (assistant principal)

Conflict and disequilibrium did not stifle reform. Change continued. Pedagogy dominated "teacher-talk." "I don't think we have ever been in a building where pedagogy is spoken all day long. It is really clear to your teachers what is valued here" (outside researcher). Teacher-leaders shared ideas about their instruction. They designed different learning environments to accommodate new practices. Teachers asked different types of questions, valued student experiences and supported student risk-taking. They designed lessons, listened to students' understandings and "rebuilt" their own understanding of mathematics with children. Some teachers began to see the inadequacies of their prior assumptions about learning. They realized what they taught was often not what students learned. The reform impacted some individuals personally. "It is hard to change people's minds. You couldn't change mine. It just so happened in my own pursuit, for my own reason, I came upon it and changed my mind." (teacher-leader)

However, after nine years of reform, about thirty percent of the school's teachers are not actively engaged in reforming mathematics. Their non-participation was not solely based on epistemological differences. The reform process perturbed existing rules, roles and relationships. It disrupted "informal" power structures. It disturbed a "business as usual" mentality. Participation, for some teachers, was too risky.

Success depended on teachers' abilities to learn and take risks. Teachers' change occurred from within, through the dialectical relationship between their actions and reflections on classroom practices. These dialectical processes were inherently autonomous.

> It is hard to change. I was in tears a lot. I would go home not knowing if what I was doing was right. I was afraid that at the end of the year the kids would not understand. It is scary to take risks. You have to say, 'Look, it is working, there are so many good things.' (teacher-leader).

Interactive mathematics instruction evolved into the development of a dialogic community. Professional sharing eliminated teacher isolation. Collegial relationships and professional discussions encouraged many teachers to take risks and learn more about mathematics (Pourdavood & Fleener, 1998). Teachers and principals became learners, decision-makers and instructional leaders. Trust, professional respect and pride in students' abilities to do contextual mathematics emerged from collaborations and common interests among some members of a transforming school community.

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